Modeling Participation and Bids in the Northeast U.S. Groundfish Fishing Vessel Buyout Program

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Abstract. An experimental buyout program was initiated in 1995 to remove fishing vessels from the Northeast United States groundfish fishery. Implemented as a reverse auction, the purpose of the pilot program was to determine the level of interest in a vessel buyout and to gain insight on the prices owners would be willing to accept to surrender their vessel and all associated fishing permits. Of the 296 eligible vessels, the pilot program drew 114 applicants with average bids of $455 thousand. Information provided by the applicants was used to evaluate the likely participation and potential cost of an expanded buyout. This paper describes the pilot buyout program and the econometric procedures used to forecast probability of participation and bids, and to estimate the number and types of vessels that could be purchased at various levels of program spending. The decision of whether to participate in the program and the magnitude of bids were modeled in two stages via the specification of a participation function and a bid function. Alternative methods for modeling these functions, such as the Tobit model and the Heckman and Cragg two stage models, are discussed. Variables found to explain participation and bids include total and groundfish revenue history, allocated days-at-sea in the groundfish fishery, gear type, expected ranking, and vessel size characteristics. The expanded buyout program, completed in April 1998, provides a unique opportunity to evaluate the accuracy of the forecasts.

Keywords: buyout, capacity, groundfish, forecast, participation/bid functions

1. INTRODUCTION

Since the passage of the Magnuson Fishery and Conservation and Management Act and establishment of the Exclusive Economic Zone (EEZ) in 1977, the fishery for groundfish in the northeastern U.S. has been managed under three fishery management plans (FMPs) developed by the New England Fishery Management Council (Council). Between 1977 and 1982, the fishery was managed primarily by quotas for cod, haddock, and yellowtail flounder. During this period, the stocks began rebuilding following historic overfishing by foreign fleets. Even as the foreign fleets were being excluded from the EEZ, the U.S. domestic fleet was experiencing an unprecedented increase in new vessel construction. This increase was due, in varying degrees, to the economic opportunity created by the displacement of the foreign fleets and increased stock abundance and to a suite of incentive programs to encourage replacement and new construction of fishing vessels. These incentive programs included the Fishing Vessel Obligation Guarantee Program, and the Fishing Vessel Capital Construction Fund Program.

Figure 1 illustrates patterns of vessel participation and entry into the northeast groundfish fishery. Due to database changes, a consistent time series could only be constructed using data from three New England states (Maine, Massachusetts, and Rhode Island). These three states comprise the majority of vessels and landings of groundfish in the northeast and are likely to be representative of the northeast region as a whole. From 1965 until 1973 an average of 581 unique vessels (i.e. fishing craft 5 gross registered tons or larger) per year participated in the New England groundfish fishery (Figure 1). Approximately 50 vessels that had not previously been identified were added annually to the fishery. However, as vessels were added others were leaving so that the net average increase was 9 vessels per year.

By historical standards the increase in the northeast fishing fleet between 1974 and 1980 was dramatic. New vessel construction peaked in 1979 at 176 vessels; an average annual increase of 22.3%. Similarly, the number of vessels added to the landings data base increased at an annual rate of 31.1%. The total number of vessels recorded as having landed groundfish in New England was 1,185 in 1980; an average annual increase of 8.7% during the seven year 1974-1980 period. Since 1980, the number of New England vessels landing groundfish has gradually declined at an average annual rate of 1.4% per year but remains at nearly twice that of the pre-Magnuson Act period.

The buildup in the northeast fishing capacity resulted in an increased number of vessels fishing on annual quotas. Without a basis for controlling the number of participants, for example effort limitation or property rights, fishing activity intensified and quotas were filled rapidly, leading to sporadic market conditions and numerous management and enforcement problems. Concomitantly, impacts on the resource were becoming evident. Growing dissatisfaction with catch quotas led to their removal and replacement with indirect controls on fishing mortality in 1982. These indirect controls (gear

Figure 1. Additions to the New England fishing fleet (1965 to 1980) and number of vessels landings groundfish in Maine, Massachusetts or Rhode Island (1965 to 1997).

restrictions and minimum fish sizes) were implemented under what was called the Interim Plan.

This plan was designed to provide adequate resource protection while a more comprehensive and effective approach could be developed. With the near doubling of the number of vessels in the New England groundfish fleet, however, such measures were apparently not sufficient and groundfish stocks continued to decline.

The current Northeast Multispecies Fishery Management Plan or Multispecies Plan was implemented in 1986. The Plan added seven more species to the management unit (three more species were added in 1991 through the amendment process) and made a number of regulatory changes. However, the basic strategy of controlling fishing mortality through indirect controls was retained. At present, ten of the species managed under this plan are defined as "regulated" or "large mesh" species: cod, haddock, pollock, yellowtail flounder, winter or blackback flounder, witch flounder, American plaice, redfish, white hake, and windowpane flounder. The three remaining "small mesh"species are red hake, silver hake, and ocean pout.

By the early 1990's, groundfish stocks had declined to record low levels. In May 1994, a major revision to the Multispecies Plan (Amendment 5), was implemented. Amendment 5 capped the number of vessels in the fishery through a limited access program, and controlled the amount of time many vessels in the fleet could spend at sea. These measures were designed to end overfishing (as defined prior to the 1997 Sustainable Fisheries Act). Subsequently, the Council be developed further modifications to the Multispecies Plan to rebuild the depleted resources. Amendment 7 was proposed by the Council in early 1996 and implemented in July 1996. The key components of Amendment 7 were the adoption of a more rigorous days-at-sea (DAS) reduction schedule, the removal of most exemptions from DAS controls, and a more flexible adjustment process to respond to specific resource conditions.

To mitigate the transitional economic impacts the Amendment 7 effort reductions were likely to have on fishing industries and marine dependent communities, several financial assistance programs were implemented. One of these programs was the Fishing Capacity Reduction Demonstration Program ($2 million), hereafter referred to as the pilot buyout program, that was initiated in June, 1995. Subsequently, $23 million was made available for the Fishing Capacity Reduction Initiative, hereafter referred to as the expanded buyout program. Although the primary objective was to provide financial assistance, the buyouts were also designed to provide some conservation benefits to the groundfish resource.

The pilot buyout program was designed to assess the level of interest in a vessel buyout program and to evaluate a variety of implementation protocols such as bidding procedures, scrapping provisions and eligibility and selection criteria. The pilot buyout program was concluded in February, 1996 with the selection of 11 vessels from a pool of 114 applicants for purchase and disposal.

Prior to money being appropriated for the expanded buyout program, the Social Sciences Branch of NMFS's Northeast Fisheries Science Center was asked to provide an estimate of how many and what kind of vessels could be removed with larger allocations of buyout money. The 114 applicants in the pilot buyout program submitted bids totaling nearly $52 million. However, additional expenditures of up to $75 million and some relaxation of the eligibility criteria was being contemplated by program administrators.

To develop forecasts of anticipated number of applicants and program costs, data from the pilot buyout were used to develop predictions of participation and bid prices in an expanded buyout program. An expanded buyout program was actually implemented in September, 1996 and concluded in April, 1998.

In this paper we focus on the methods that were used to develop forecasts for the expanded buyout. As the expanded program has already been completed, we also compare our forecasts of participation and program costs to actual program performance. Throughout we do not attempt to justify the buyout program or try to assess whether the buyouts had or will have any lasting conservation benefit.

2. DESCRIPTION OF THE PILOT BUYOUT PROGRAM

Eligibility for the pilot buyout program was limited in several ways. First, participation was limited to two of the six different multispecies limited access permit categories. Second, vessel owners were required to demonstrate that at least 65% of their fishing revenue was derived from combined landings of the ten regulated large mesh groundfish in three of four years from 1991 to 1994. Lastly, vessel owners were required to demonstrate that their vessel was capable of fishing under its own power in Federal waters.

Participation in the buyout was voluntary and bids were solicited through a reverse auction. The reverse auction process required that each vessel owner prepare a bid or price at which he/she would be willing to render the vessel in an un-fishable condition and surrender all Federal fishing permits. Selection of vessels was based on a hierarchical ranking of the ratio of the bid to the vessel's groundfish revenue. Bids were not subject to negotiation upon acceptance by the Government. However, the selected applicants were given an opportunity to reconsider their decision to participate in the buyout. Successful bidders that then decided not to participate were removed from further consideration and the next highest ranked vessel was selected. Vessel owners were not required to surrender their right to reenter the multispecies fishery or enter any other fishery provided they could purchase a vessel with the appropriate permits.

3. DECISION MODELING

Presented with a buyout opportunity, a vessel owner might face two sequential (and possibly interrelated) decisions; 1) whether or not to apply for the buyout and 2) what dollar amount to declare as a bid. The first stage is a discrete choice of whether or not to submit an application. Once the decision to participate has been made, the second stage is selecting a bid that is worthwhile for the owner and competitive given the selection criterion. Although bids were only observed from those individuals that chose to participate, data on landings, vessel characteristics, and permits were available for the pool of vessels that met the minimum permit and groundfish revenue criteria. These data formed the basis from which statistical models of buyout program participation and bidding were developed.

Several alternative statistical methods were available to model the bidding process described above. The participation stage can easily be modeled using a standard Logit or Probit regression. This gives a characterization of the likelihood that an individual with a certain set of characteristics will participate in the buyout program. However, develping a model to predict the likely size of a bid is not as straight forward. The bid is a limited dependent variable. Bids of individuals who did not participate are not observed, and the qualification criteria restrict access to only a sub-set of the population of limited access permit holders. A simple, linear regression specification is not appropriate due to the correlation between regression errors and the explanatory variables (Maddala, 1983). To overcome this problem, three alternative statistical models were considered; the Tobit model (Tobin, 1958), Cragg's double-hurdle model (Cragg, 1971), and Heckman's sample selection model (Heckman, 1976). Here we discuss these models only in very general terms.

For the Tobit model, the predicted bid is given by the expected bid conditional on a positive bid being observed, times the probability that a positive bid will be observed. A Tobit model of the bid can estimated by including the inverse Mills ratio (IMR) obtained from a first stage Probit that includes the same regressors as the bid function (and with standard errors appropriately adjusted for the presence of a fitted value as a regressor). The inclusion of the IMR effectively accounts for the correlation between the errors and regressors. Although the Tobit model has received extensive use in demand analysis, it was not utilized in our work due to the restriction that the same factors are assumed to affect the probability of bidding and the expected magnitude of the bid given that a bid is made. In order to relax this restriction, we first examined the double hurdle model suggested by Cragg (1971). In this model the variables affecting the probability of a positive bid are allowed to differ from those affecting the expected bid.

As usually applied, in the Cragg model, the probability and bid regressions are assumed to be independent. This somewhat unrealistic assumption permits estimation to proceed in two steps by which the probability of a positive bid is estimated using a Probit or Logit regression and the coefficients of the bid function are estimated by a truncated regression for the positive bids. In those cases where the variables in each regression are the same, Cragg's model is identical to a Tobit model.

As a second alternative to the Tobit specification we also considered Heckman's sample selection model. Like Cragg's model, this model also allows the variables influencing each decision to differ, but does not require that the two equations be independent. As with a Tobit model, the Heckman model can be estimated by including in the bid regression the IMR obtained from a first stage Probit model. However, in the Heckman model the bid function need not contain the same regressors as the probability model. Both the Cragg and Heckman models were estimated using LIMDEP (Greene, 1992).

3.1 Description of Variables

The decision to participate in the buyout is assumed to be influenced by a vessel owner's financial status, past and expected future earnings from fishing, age and other socioeconomic factors, vessel condition, and expectation of being selected. The magnitude of the declared bid probably depends on similar, but not necessarily the same, factors. The bid decision is influenced by what the vessel, given its features and condition, is worth to the vessel owner in terms of income generating potential. The pilot buyout application did not ask for particulars regarding the owner's financial status, demographic characteristics, or vessel condition and features. Therefore, vessel characteristics and performance data available through landings and permit information systems were used to explain participation and bidding.

Table 1 lists and briefly describes the variables used in modeling buyout participation and bids.

3.2 Participation Model Results

The data set comprised all vessels that submitted a bid (participants) in the pilot program and all vessels identified from NMFS landings data as meeting the eligibility requirements. Of the 114 participants, only 101 were included in the estimation due to missing observations on one or more of the independent variables. The total number of non-participants was 153. Table 2 shows the results from estimating a Logit and Probit model to describe the participation decision.

The dependent variable for the participation models was the binary variable PART. The resulting coefficients can then be used to calculate probabilities of participation for given individual characteristics.

The variable labeled RATIO is a measure of dependence on groundfishing. This variable has a positive sign and was statistically significant indicating that vessel owners who are highly dependent on groundfish are more likely to participate in a buyout perhaps because they are not easily able to switch to alternative fisheries.

Table 1. Variables Used in Modeling Participation and Bids

			When used in participation models (n = 254)		When used in bid models (n = 98)	
Symbol	Name	Description	Mean	Std. deviation	Mean	Std. deviation
PART	Participation	Dependent variable for participation model: 1 = submitted application, 0 = did not submit application	0.40	0.49	-	-
BID	Bid	Dependent variable for bid model: amount of bid, in thousands of dollars, submitted by applicant.	-	-	407.42	306.61
RATIO	Ratio	Average ratio of yearly groundfish revenue to total revenue (1991-1994)	0.87	$0.92E^{-1}$	-	-
TOTREV	Total Revenue	Average total yearly revenue, in thousands of dollars, from all species (1991-1994)	341.67	210.66	386.51	246.71
DAS	Days-at-sea allocation	Total groundfish days-at-sea allocation for the 1997 fishing year (May through April)	111.68	24.28	115.22	23.09
GEAR	Gear	1 = gillnet, 0 = other gear (based on 1993 primary gear)	0.19	0.40	0.07	0.26
AGE	Vessel Age	Age of vessel at time application was submitted	17.85	8.64	20.41	10.91
EXPSCORE	Expected Score	The predicted bid from the Cragg model divided by average yearly groundfish revenue over the period 1991-1994.	0.93	0.43	-	-
HP	Horse Power	Vessel's total propulsion engine horse power	-	-	525.87	213.42

Table 2. Participation Model Results

	Logit Model (Chi-Squared = 68.47)			Probit Model (Chi-Squared = 69.16)		
Variable	Coefficient	Standard error	t-ratio	Coefficient	Standard error	t-ratio
Constant	-9.51	1.90	-5.00	-5.56	1.06	-5.27
RATIO*	8.89	1.97	4.52	5.23	1.11	4.70
TOTREV*	$0.24E^{-2}$	$0.10E^{-2}$	2.37	$0.15E^{-2}$	$0.62E^{-3}$	2.37
DAS	$-0.16E^{-1}$	$0.95E^{-2}$	-1.67	$-0.10E^{-1}$	$0.58E^{-2}$	-1.75
GEAR*	-1.21	0.54	-2.23	-0.75	0.31	-2.40
AGE*	$0.75E^{-1}$	$0.22E^{-1}$	3.38	$0.45E^{-1}$	$0.13E^{-1}$	3.45
EXPSCORE*	1.06	0.46	2.32	0.66	0.27	2.44

*Significant at the 5% level in both models
n = 254

The positive sign of the TOTREV coefficient indicates that, given the same percentage dependence on groundfish, larger vessels with higher overall revenues are more likely to participate.

The DAS variable has a negative coefficient which indicates that, all else equal, vessels with a large DAS allocation are more likely to remain in the fishery. Since days-at-sea allocations could also be a measure of groundfish dependence, this finding is somewhat counter-intuitive. Perhaps the reason for why this variable is negative is because days-at-sea have an inherent value in their ability to produce income and vessels that have relatively large DAS allocations tend to keep them for that purpose.

The coefficients on GEAR and AGE indicate that older non-gillnet (mostly bottom trawlers) vessels are more likely to participate in a buyout program.

Table 3. Within Sample Predictions of Participation Model (Logit and Probit Specifications)

	Model Predictions		
Actual	Non-participants	Participants	Total
Non-participants	123	30	153
Participants	40	61	101
Total	163	91	254

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The coefficient on the EXPSCORE variable was expected to be negative indicating that owners who anticipated a low score, and therefore a higher chance of being selected, would be more likely to submit a bid. One possible explanation for the positive coefficient is that since non-participating vessels were smaller and less dependent on groundfish, perhaps they are better able to move to alternative fisheries and remain profitable even though many of the non-participants had a good chance of being selected.

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Table 3 shows that the within sample predictive capabilities of both the Logit and Probit models are identical. Both models correctly predicted 61 of the 101 participants and 123 of the 153 non-participants. A simple rule that always predicts no participation would have been correct for 153 of the 254 observations. The Logit and Probit models correctly predicted 184 of the 254 observations.

3.4 Bid Model Results

The participation model provides a method of predicting the number of participants in an expanded vessel buyout program. To estimate the bids that individual vessel owners would offer, a predictive model of buyout bids was developed. Using the sample of pilot buyout participants, a bid function based on a regression of TOTREV, AGE, HP, GEAR, DAS on actual submitted bids (BID). Of the 114 bids submitted in the Pilot program, only 98 observations were used due to missing observations and the removal of some extreme bid values.

The BID variable was measured in $1,000's so the parameter estimates are interpreted as the unit change in the buyout offer in thousands of dollars associated with a unit change in the explanatory variable. For example, a unit change in total revenue (i.e. a $1,000 change in total revenue) results in a $780 increase in the offer price. Similarly, the marginal bid value of a day-at-sea, as measured by the DAS variable, was estimated to be $2,880 when the Cragg model was used and $1,650 when the Heckman model was used. In the participation models the DAS variable was negative indicating a propensity to retain something of value. The coefficients in the bid models provide a measure of that value.

The positive coefficients on HP and GEAR suggest that non-gillnet (mostly trawlers) vessels with more engine power are valued more highly than other vessels.

AGE in the Cragg model was negative indicating that older vessels are valued less highly. A negative coefficient for AGE was also expected in the Heckman model. However, in both models the coefficient was insignificant.

Table 4 presents the estimation results for the second stages of the Cragg double hurdle and Heckman sample selection models.

4. FORECASTS AND ACTUAL BEHAVIOR IN THE EXPANDED BUYOUT PROGRAM

The expanded buyout program was structured similarly to the pilot program, but two features were different. The first was that vessels with any of the seven limited access permit types established under Amendment 7 were eligible for the expanded program instead of the three in the pilot program. The second feature was that vessels could be transferred to eligible entities for non-fishing uses.

Earlier modeling of the pilot program was completed before the expanded program was designed. At that time, the 65% groundfish revenue eligibility rule was being reconsidered. Table 5 provides the results of applying both the Cragg and Heckman models to 1) all limited access vessels and 2) limited access vessels meeting the 65% groundfish eligibility rule. These results are compared to what occurred in the expanded program. The last two rows of Table 5 report average and total ton days. A ton day is a vessel's days-at-sea allocation multiplied by its gross tonnage. This is provided because it is a way of weighting days-at-sea by vessel sizes, and provides a measure of effective fishing effort.
The expanded program received 140 bids totaling $52.7 million. The average bid was $376,200 and the average percent groundfish revenue was 87%. When applied to all limited access vessels regardless of their level of groundfishing, the Cragg model predicts 235 participants bidding a total of $98.9 million and the Heckman model predicts 311 participants bidding a total of $105.8 million. The average bid of $340,100 from the Heckman model matches the expanded program average bid somewhat better than the average bid of $420,800 from the Cragg model. The average percent groundfish revenue from the Cragg and Heckman models was 40% and 36%, respectively. In general, the Cragg model predicted more participation of larger vessels with somewhat higher days-at-sea allocations so that the resulting average bid was higher than the average bid in the Heckman model.

Because vessels not meeting the 65% groundfish revenue eligibility rule could not submit a bid to the expanded program, these vessels were removed from the predicted participant group in each of the models. After these vessels were eliminated, the Cragg model predicted 88 participants bidding a total of $43.5 million while the Heckman model predicted 92 participants bidding a total of $41.7 million. The average bid of $453,400 from the Heckman model and $494,800 from the Cragg model are both substantially higher than the average bid from the expanded program. The ineligible vessels removed from the predictions were smaller vessels with lower days-at-sea allocations leaving the larger, groundfish vessels with predicted higher bids.

Both the Cragg and Heckman models predicted participation by fewer eligible vessels than actually participated in the expanded program. However, since the predicted vessels were larger, groundfish intensive vessels with more allocated days-at-sea, the average predicted bid was higher than actual and so the total program cost matched somewhat closer.

Since the expanded program ultimately spent $23 million to purchase 68 vessels, Table 6 duplicates Table 5 but only for those vessels that could be purchased with $23 million.

Table 4. Bid Model Results

	Cragg Model (Log-likelihood = -626.07)			Heckman Model (Log-likelihood = -635.09)		
Variable	Coefficient	Standard error	t-ratio	Coefficient	Standard error	t-ratio
Constant	-485.21	199.20	-2.44	-351.38	169.10	-2.08
TOTREV*	0.78	0.15	5.19	0.78	0.13	6.01
AGE	-0.49	3.19	-0.16	2.18	2.59	0.84
HP*	0.41	0.15	2.74	0.35	0.13	2.74
GEAR	52.96	112.60	0.47	37.81	72.04	0.53
DAS**	2.88	1.28	2.25	1.65	0.99	1.66
Sigma***	184.22	16.43	11.21	-	-	-
Lambda	-	-	-	50.96	60.69	0.84

*Significant at the 5% level in both models
**Significant at the 5% level in Cragg model only
***Significant at the 1% level
n = 98

Table 5. Comparison of Predicted Participants to Actual Participants in the Expanded Program

	Cragg model		Heckman model		
	Without 65% groundfish rule	With 65% groundfish rule	Without 65% groundfish rule	With 65% groundfish rule	Expanded program
Number of vessels	235	88	311	92	140
Total cost (millions)	$98.9	$43.5	$105.8	$41.7	$52.7
Average expected bid	$420,800	$494,800	$340,100	453,400	$376,200
Number of vessels at total cost of $23 million (size of expanded program)	55	54	58	52	68
Number of vessels that participated in the expanded program	60	60	60	60	140
Average ratio of groundfish revenue to total revenue	0.40	0.94	0.36	0.93	0.87
Average annual total revenue	$431,700	$462,700	$345,600	$434,700	$391,000
Average annual groundfish revenue	$187,000	$467,200	$143,300	$436,800	$351,400
Average annual allocated days-at-sea	100	120	97	117	113
Average vessel age	19	20	23	23	18
Average horse power	675	654	598	634	535
Average vessel length (feet)	74	76	70	74	67
Average gross tons	128	136	108	128	109
Average ton days	13,110	16,856	10,854	15,605	13,176
Total ton days (millions)	3.08	1.48	3.38	1.44	0.90

Table 6. Comparison of Predicted Participants to Actual Participants in the Expanded Program if Total Cost is Restricted to $23 Million.

	Cragg model		Heckman model		
	Without 65% groundfish rule	With 65% groundfish rule	Without 65% groundfish rule	With 65% groundfish rule	Expanded program
Number of vessels at total cost of $23 million (size of expanded program)	55	54	58	52	68
Average expected bid	$412,400	$419,100	$396,500	$428,200	$331,600
Number of vessels that participated in the expanded program	37	37	36	36	68
Average ratio of groundfish revenue to total revenue	0.95	0.95	0.95	0.95	0.89
Average annual total revenue	$438,300	$444,600	$420,700	$449,600	$344,500
Average annual groundfish revenue	$445,400	$451,200	$428,100	$457,400	$326,900
Average annual allocated days-at-sea	115	115	113	115	112
Average vessel age	22	21	21	20	19
Average horse power	551	556	533	552	519
Average vessel length (feet)	73	73	72	74	66
Average gross tons	127	128	124	130	102
Average ton days	14,831	15,016	14,367	15,324	12,288
Total ton days (millions)	0.82	0.81	0.83	0.80	0.84

When restricted to a total program cost of $23 million, the Cragg and Heckman models behaved similarly even when ineligible vessels were removed. Both models and both scenarios predicted participation by 52 to 58 vessels. Predicted average bids ($396,500 to 428,200) in the two models were similar and both were higher than the actual average bid of $331,600 for vessels purchased through the expanded program. Both models predicted participation by similar sized vessels and with nearly identical levels of groundfish dependence. The average percent groundfish in both models and scenarios was 95% and the average annual groundfish revenue ranged from $428,100 to $457,400.

5. CONCLUSIONS AND EXTENSIONS

The modeling procedures employed in our study were useful for forecasting and evaluating vessel buyout program participation and costs. The Heckman model was particularly suited to our circumstances. However, several aspects of the statistical properties of the estimators need further investigation. Limited dependent models have been shown to be prone to heteroskedasticity (Greene, 1990), and the Cragg and Heckman models are no exception. Also results reported in Tables 5 and 6 do not include confidence intervals for the model predictions. Additional work will focus on these statistical issues as well as an examination of alternative estimation procedures. Other work will include reconsideration of the use of a predicted explanatory variable (expected score) in the participation model and using a probit model for the Cragg specification. The probit model would offer a more consistent comparison between the resulting forecasts from the Cragg and Heckman specifications.

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